POLARIMETRIC PASSIVE REMOTE SENSING OF WIND-GENERATED SEA SURFACES AND OCEAN WIND VECTORS

S. H. Yueh, R. Kwok, F. K. Li, S. V. Nghiem and W. J. Wilson

Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109

J. A. Kong

Research Laboratory of Electronics
Massachusetts Institute of Technology
Cambridge, MA 02139

Abstract

This paper investigates the polarimetric passive remote sensing of wind-generated sea surfaces and its application to the wind vector retrieval. The small perturbation method (SPM) is applied to the Stokes vectors of the thermal emission from random rough surfaces described by anisotropic directional spectra. The polarimetric scattered fields for rough dielectric surfaces are derived to the second order by using the SPM. The second-order scattered fields are found to be coherent, and present the lowest-order corrections to the specular reflection coefficients of the surfaces. In addition, the cross-polarized components of the coherent fields are reciprocal and not zero when the azimuth angle of the incidence direction is not aligned with the symmetry direction of surfaces. To verify the accuracy of the SPM, a Monte Carlo simulation is performed to calculate the Stokes vectors of the emission from the simulated one-dimensional random rough surfaces with a power-law spectrum for various observation angles and surface parameters. The theoretical results of the SPM for all four Stokes parameters are in excellent agreement with the numerical results obtained from the Monte Carlo simulation. Moreover, the second-order coherent fields are found to be required for the theoretical evaluation of the third and fourth Stokes parameters. Without that, the reflectivities of random rough surfaces would be significantly over-estimated, and the signs of the third and fourth Stokes parameters would be incorrect. The SPM is then applied to small-scale sea surfaces described by an empirical surface spectrum. The forms of the model function of the Stokes parameters are presented. It is found that the polarimetric radiometry makes it possible to retrieve the ocean wind vector with a single-azimuth-look sensor design, which will ease the beam-scanning mechanism and will be free from the complexity associated with the data co-registration required for multi-azimuth-look designs.